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ABSTRACT

This document contains the instructional materials developed and presented in a 39-hour course for employees of an automotive assembly plant. The course is an introductory look at blueprint reading using blueprints similar to those used at the company. Worksheets and tests relating to the blueprints are included. The course covers an introduction, metric units, tolerancing, precision measuring, and reading blueprints. (KC)

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ED 379 516

"BASIC STRATEGIES IN BLUEPRINT READING"

FOR

UNITED TECHNOLOGIES - AUTOMOTIVE

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1994 VISIONS, NATIONAL WORKPLACE LITERACY GRANT
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CE 3367

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INTRODUCTION

"Basic Strategies in Reading Blueprints" was a 39 hour course taught for employees of United Technologies Automotive, Inc., as part of a National Workplace grant. Employees attended 1 1/2 hour sessions twice a week for thirteen weeks. The course was a result of a needs survey given to employees about what types of instruction they most preferred. The course is an introductory look at blueprint reading, however, many of its concepts are difficult to comprehend, hence one reason for a high dropout rate for the class. The course participants were mid-level to low literates who "see" blueprints during assembly of auto parts but, in general, did not possess knowledge of how to interpret them. Eighteen employees out of thirty six original class members persisted and mastered the materials.

This course is best taught by someone with experience with industrial blueprints. Required materials for the course include company blueprints, company parts that correspond to the blueprints, and assess to digital calipers or the measuring tools used at that industry. The specific blueprints used at United Technologies have been removed to preserve confidentiality. Worksheets and tests relating to the blueprints have been retained to be used as models for company specific curriculum.

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"The content of this Basic Strategies in Reading Blueprints were developed under a grant from the Department of Education. However, those contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government."

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GOALS

"BASIC STRATEGIES IN READING BLUEPRINTS FOR UT WORKERS"

CYCLE III
May 2, 1994 - July 29, 1994

---To increase knowledge of metric units of measurements

---To develop a correlation between metric units and customary units

---To increase knowledge of the tolerancing systems used on prints: "+/-" and "GDT"

---To increase knowledge in using precision measuring instruments

---To increase knowledge of blueprint terminology

---To develop skills necessary to read blueprints

---to instill in employees a love for learning as well as pride in displaying knowledge

---To promote teamwork and leadership

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CYCLE III

CLASSROOM FORMAT AND EXPECTATIONS

Classroom format will be informal but structured.

Participants will be expected to attend classes except due to emergencies.

Participants will be expected and encouraged to participate in classroom discussions and activities.

Participants will be expected to respect the rights of others to have and express their opinions.

ASSESSMENT

Employees must attend class at least 80% of scheduled time ***(no more than 5 absentees within 24 scheduled instructional class meetings)*** in order to be considered a ***"completer".***

Employees who can not attend class for any reason are responsible for contacting the instructor and attempting to make-up all missed material in a timely manner, not to exceed two "2" class meetings.

Employees must complete all handouts and worksheets with a minimum of 75% accuracy.

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CYCLE III

LESSON PLAN

"BASIC STRATEGIES IN READING BLUEPRINTS FOR UT WORKERS"

OBJECTIVES:

Employees will be able to take measurements using metric units

Employees will be able to use precision measuring instruments competently

Employees will be able to identify and define blueprint terminology

Employees will be able to communicate using blueprint terminology

Employees will be able to visualize and interpret various aspects of blueprints

Employees will be able to demonstrate their ability to read blueprints

INSTRUCTOR PERFORMANCE:

Instructor will assist students in obtaining body measurements in metric units that will be used for relativeness.

Instructor will give students basics on the "+/-" and "GDT" tolerancing systems as well as instructions on relative math.

Instructor will give students definitions of basic blueprint reading terminology.

Instructor will assist students in becoming competent in using precision measuring instruments.

Instructor will assist students in gaining insight that will enable them to visualize and interpret aspects of blueprints.

Instructor will assist students in becoming primarily proficient in reading blueprints.

Instructor will periodically give students handouts/exercises to be completed either in class or at home in effort to facilitate learning.

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CURRICULUM

CYCLE III: May, 2 - July, 29

Week 1
May 2 - May 5

- Course Introduction
- Complete Forms
- IEPS
- Intake Survey

Week 2
May 9 - May 12

- Introduction to Metric Units
  - Body references
  - Applications

Week 3
May 16 - May 19

- Tolerancing
  - +/-
  - GDT
  - Math
  - Applications

Week 4
May 23 - May 26

- Precision Measuring
  - Calipers
  - Feel
  - Applications

Week 5 - 12
May 30 - Jul 22

- READING BLUEPRINTS
  - Terminology
    - lines
    - views
    - title block
    - notes
    - bill of materials
  - Dimensioning
  - Symbols/Abbreviations
  - Types of Drawings
  - Freehand drawing
  - Applications

Week 13
Jul 26 - Jul 29

CLOSURE

OUTTAKE SURVEY

TASK ANALYSIS

UNITED TECHNOLOGIES AUTOMOTIVE

JOB TITLE: RECEIVING INSPECTOR

JOB TASK: INSPECTION

SUBTASKS	SKILL APPLICATIONS
1. GO INTO RECEIVING AND RETRIEVE PARTS TO BE INSPECTED FROM PALATE. CHECK TO SEE IF THERE ARE ***"HOT"*** PARTS NEEDING INSPECTION.	1. ABILITY TO FOLLOW DIRECTIONS FROM ASSIGNMENT SHEET AND ORALLY FROM SUPERVISOR.
2. CHECK TO SEE IF READABLE BARCODES ARE PRESENT ON BOXES CONTAINING PARTS.	2. VISUAL CHECK
3. RANDOMLY SELECT 50 SAMPLE PARTS FROM EACH BATCH OF PARTS TO BE INSPECTED.	3. ABILITY TO COUNT AND RECOGNIZE NUMBERS.
4. RETURN TO INSPECTION SITE TO INSPECT PARTS.	4. NONE
5. RETRIEVE BLUEPRINT OF PART FROM FILES VIA PART NUMBER.	5. ABILITY TO "READ" NUMBERS. ABILITY TO UTILIZE FILING SYSTEM. ABILITY TO UTILIZE PERTINENT INFORMATION FROM THE TITLE BLOCK OF BLUEPRINTS.
6. USING COMPUTER, GO TO "WAREHOUSE" SCREEN ON COMPUTER; LOCATE AND SELECT RELEVANT PART NUMBER; ENTER "QCPEND" FOR PENDING.	7. ABILITY TO USE COMPUTER AND VARIOUS FUNCTIONS KEYS ON COMPUTERS.
7. USING COMPUTER GO TO "INSPECTION INSTRUCTION/RESULTS" SCREEN WHICH LISTS ALL OF THE DIMENSIONS ON THE PART TO BE INSPECTED.	8. SAME AS ABOVE
8. VISUALLY COMPARE PART TO PRINT.	9. VISUAL INSPECTION.
9. REFERRING TO PRINT AND DIMENSIONS OUTLINED ON THE SCREEN, USE CALIPERS TO MEASURE DIMENSIONS ON THE PART.	10. ABILITY TO USE AND READ CALIPERS. ABILITY TO INTERPRET BLUEPRINTS.

10. ENTER HIGHEST AND LOWEST DIMENSION FOR EVERY 50 SAMPLE PARTS ON COMPUTER. ENTER "A" OR "R" FOR ACCEPTED OR REJECTED. IF "R" ENTER# OF REJECTED PIECES. HIT F8 TO CHECK FOR A SECOND PAGE OF DIMENSIONS.	11. ABILITY TO INTERPRET AND ANALYZE NUMBERS. ABILITY TO DETERMINE IF A NUMBER IS WITHIN TOLERANCE OF A GIVEN SPECIFICATION. ABILITY TO USE COMPUTERS AND FUNCTION KEYS. ABILITY TO WORK INDEPENDENTLY.
11. HIT "CLEAR" TO GO TO "ID ON MATERIAL" SCREEN. ENTER "C" FOR STATUS TO CLEAR THE PART FROM THE COMPUTER.	12. ABILITY TO USE COMPUTER AND FUNCTION KEYS. ABILITY TO WORK INDEPENDENTLY.
12. FILL OUT REJECT OR ACCEPT INSPECTION STICKERS.	13. ABILITY TO WRITE.
13. RETURN BLUEPRINTS TO FILE	14. ABILITY TO UTILIZE FILING SYSTEM.
14. RETURN SAMPLE PARTS TO RECEIVING TO THEIR PERSPECTIVE BOXES. APPLY "ACCEPTED" STICKER TO BOX TO GIVE CLEARANCE TO THE STOCKROOM. APPLY "REJECTED" STICKER TO BOX TO AWAIT DISPOSITION FROM SUPERVISOR.	15. ABILITY TO FOLLOW DIRECTIONS. ABILITY TO WORK INDEPENDENTLY.

Jacqueline Shuler — 2 June 94
JACQUELINE SHULER, INSTRUCTOR — DATE

Allen Richardson — 6-2-94
ALLEN RICHARDSON, SUPERVISOR — DATE

Joyce J. Boneparte — June 2, 1994
JOYCE BONEPARTE, EMPLOYEE — DATE

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BLUEPRINT READING - CYCLE III

INTAKE SURVEY

NAME _____ DATE _____

SCORE _____

DIRECTIONS: USE THE ATTACHED BLUEPRINT TO ANSWER THE FOLLOWING QUESTIONS.

ANGLE BRACKET (BP-6A)

1. HOW MANY ANGLE BRACKETS ARE REQUIRED? _____

2. WHAT KIND OF LINES ARE (A) & (B)? _____

3. WHAT KIND OF LINES ARE (E) (L) (C) (D) & (K)? _____

4. DETERMINE THE OVERALL LENGTH OF THE BRACKET ?
_____

5. DETERMINE THE OVERALL WIDTH OF THE BRACKET. _____

6. WHAT IS THE OVERALL HEIGHT OF THE BRACKET? _____

7. WHAT IS DIMENSION (A)? _____

8. WHAT IS DIMENSION (B)? _____

9. WHAT LINE IN THE RIGHT SIDE VIEW REPRESENTS SURFACE (F) IN THE FRONT VIEW? _____

10. WHAT SURFACE IN THE TOP VIEW IS REPRESENTED BY LINE (C) IN THE RIGHT SIDE VIEW? _____

11. NAME THE THREE VIEWS THAT ARE USED TO DESCRIBE THE SHAPE AND SIZE OF THE PART? _____, _____, _____

12. NAME THE MATERIAL SPECIFIED FOR THE BRACKET: _____

13. HOW MANY ANGLE BRACKETS ARE REQUIRED? _____

14. WHAT SURFACE IN THE TOP VIEW IS REPRESENTED BY LINE (C) IN THE RIGHT SIDE VIEW? _____

15. WHAT LINE IN THE RIGHT SIDE VIEW REPRESENTS SURFACE (J) IN THE FRONT VIEW? _____

16. WHAT LINE IN THE TOP VIEW REPRESENTS SURFACE (O) IN THE RIGHT SIDE VIEW? _____

17. WHAT LINE IN THE FRONT VIEW REPRESENTS SURFACE (H) IN THE TOP VIEW? _____

18. WHAT ENCIRCLED LETTER DENOTES AN EXTENSION LINE? _____

19. WHAT ENCIRCLED LETTER IN THE FRONT VIEW DENOTES AN OBJECT LINE? _____

20. GIVEN A SPECIFICATION 12.1 mm ± .3, WHAT IS THE MINIMUM AND MAXIMUM READING? _____MIN _____MAX

21. IN THE TITLE BLOCK OF A BLUEPRINT, WHAT DOES A SCALE OF "2X" MEAN?

_____

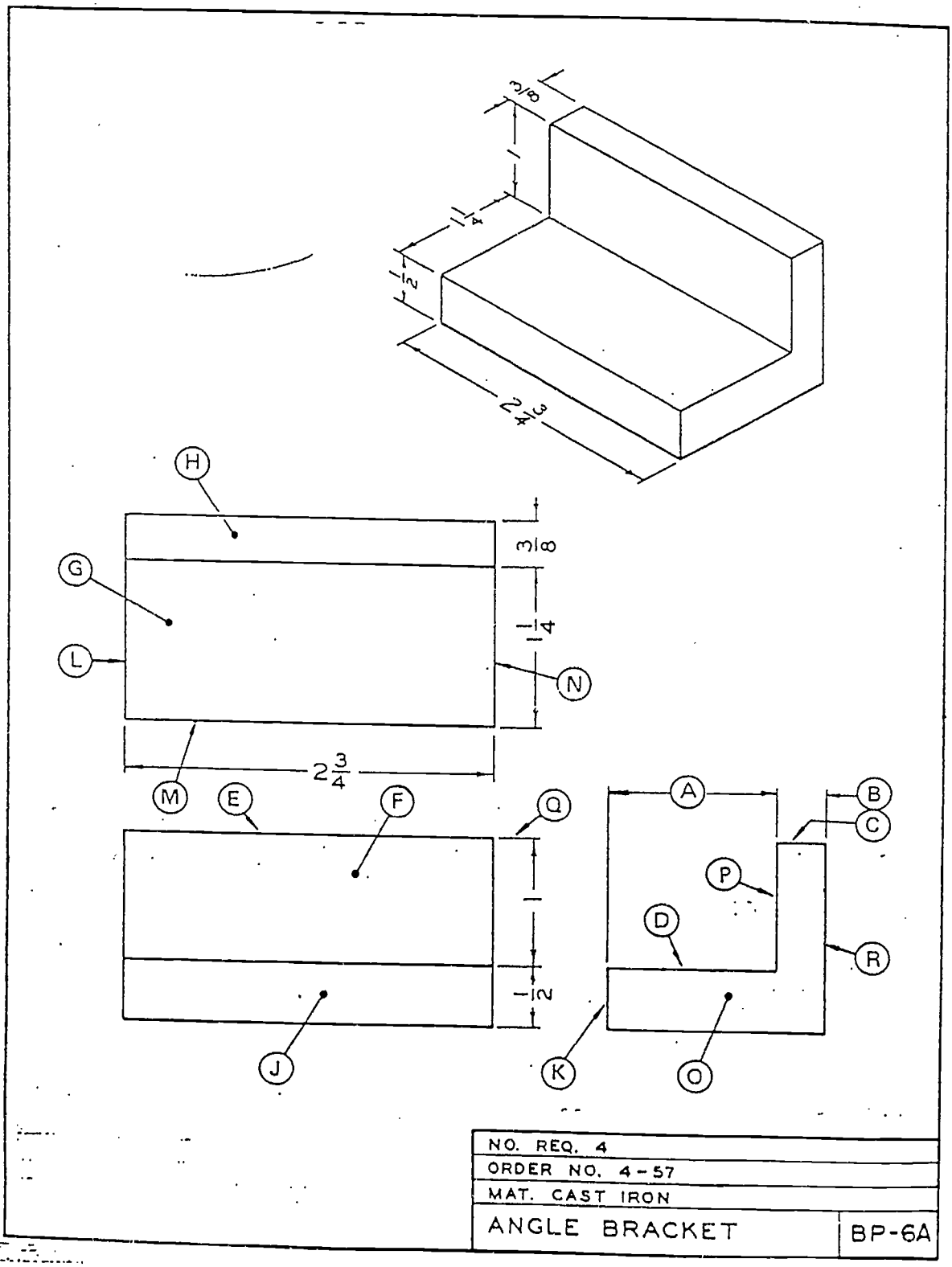
22. YOUR GIVEN A PLATE WITH A .75" ± .005 HOLE TO BE MATED TO A ROD WITH A DIAMETER OF 3/4" ± .005". IF THE HOLE IS DRILLED .75" AND THE ROD IS MADE ON THE HIGH SIDE OF ITS TOLERANCE, WILL THE ROD FIT INSIDE THE HOLE? _____YES _____NO

EXPLAIN YOUR ANSWER: _____

_____

_____

_____



NO. REQ. 4	
ORDER NO. 4-57	
MAT. CAST IRON	
ANGLE BRACKET	BP-6A

UNITED TECHNOLOGIES - ADVANCING THROUGH EDUCATION
CYCLE III

OUTTAKE SURVEY

NAME _____ DATE _____

DIRECTIONS: USE THE ATTACHED BLUEPRINT TO ANSWER THE FOLLOWING QUESTIONS. REMEMBER: THINGS BECOME A LITTLE CLEARER WHEN YOU PROJECT!!! G O O D L U C K !!!

1. WHAT IS THE NAME OF THE PART? _____

2. WHAT IS THE OVERALL HEIGHT OF THE PART? _____

3. WHAT ARE THE LINES MARKED (A) AND (B) CALLED?
_____

4. WHAT DO THE LINES MARKED (A) REPRESENT?
_____

5. WHAT TWO LINES IN THE TOP VIEW REPRESENT THE SLOT SHOWN IN THE FRONT VIEW? (ask if you are not sure where the slot is)
_____ _____

6. WHAT LINE IN THE FRONT VIEW REPRESENTS SURFACE (Q) IN THE RIGHT SIDE VIEW? _____

7. WHAT LINE IN THE FRONT VIEW REPRESENTS SURFACE (D) IN THE TOP VIEW? _____

8. WHAT LINE IN THE TOP VIEW REPRESENTS SURFACE (J) IN THE FRONT VIEW? _____

9. WHAT LINE IN THE SIDE VIEW REPRESENTS SURFACE (D) IN THE TOP VIEW?
_____

10. WHAT IS THE DIAMETER OF THE HOLES? _____

11. WHAT IS THE CENTER-TO-CENTER DIMENSION OF THE HOLES?
_____

12. ARE THE HOLES DRILLED ALL THE WAY THROUGH THE SLIDE?
_____

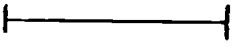
13. DETERMINE DIMENSION (S). (show your math !!!) _____

14. WHAT KIND OF LINE IS (M)? _____

15. WHAT KIND OF LINE IS USED AT (O) AND (P)? _____

DIRECTIONS: USED YOUR GENERAL KNOWLEDGE TO ANSWER THE FOLLOWING QUESTIONS:

16. USING YOUR BODY PART(S) , APPROXIMATELY HOW LONG IS THIS LINE? CIRCLE THE BEST ANSWER.



A. 30 MM B. 5 MM C. 60 MM

17. YOU ARE GIVEN A SPECIFICATION OF 12.6 mm FOR A HEIGHT OF A HOUSING
11.8 mm
ON A BLUEPRINT. YOU USE YOUR CALIPER TO MEASURE THE HEIGHT OF THE HOUSING. THE READING ON THE CALIPER IS 12.58. IS THE HEIGHT OF THE HOUSING WITHIN TOLERANCE? _____YES _____NO

18. LIST ANY INFORMATION THAT WILL BE FOUND IN THE TITLE BLOCK OF A BLUEPRINT?

_____ _____
_____

19. HOW IS A REVISION IDENTIFIED ON A BLUEPRINT?

_____

20. IN YOUR OWN WORDS, WRITE WHAT ZONES ARE AND HOW THEY ARE USED ON A BLUEPRINT. (Don't be timid in your description. Use the back if needed)

_____

_____

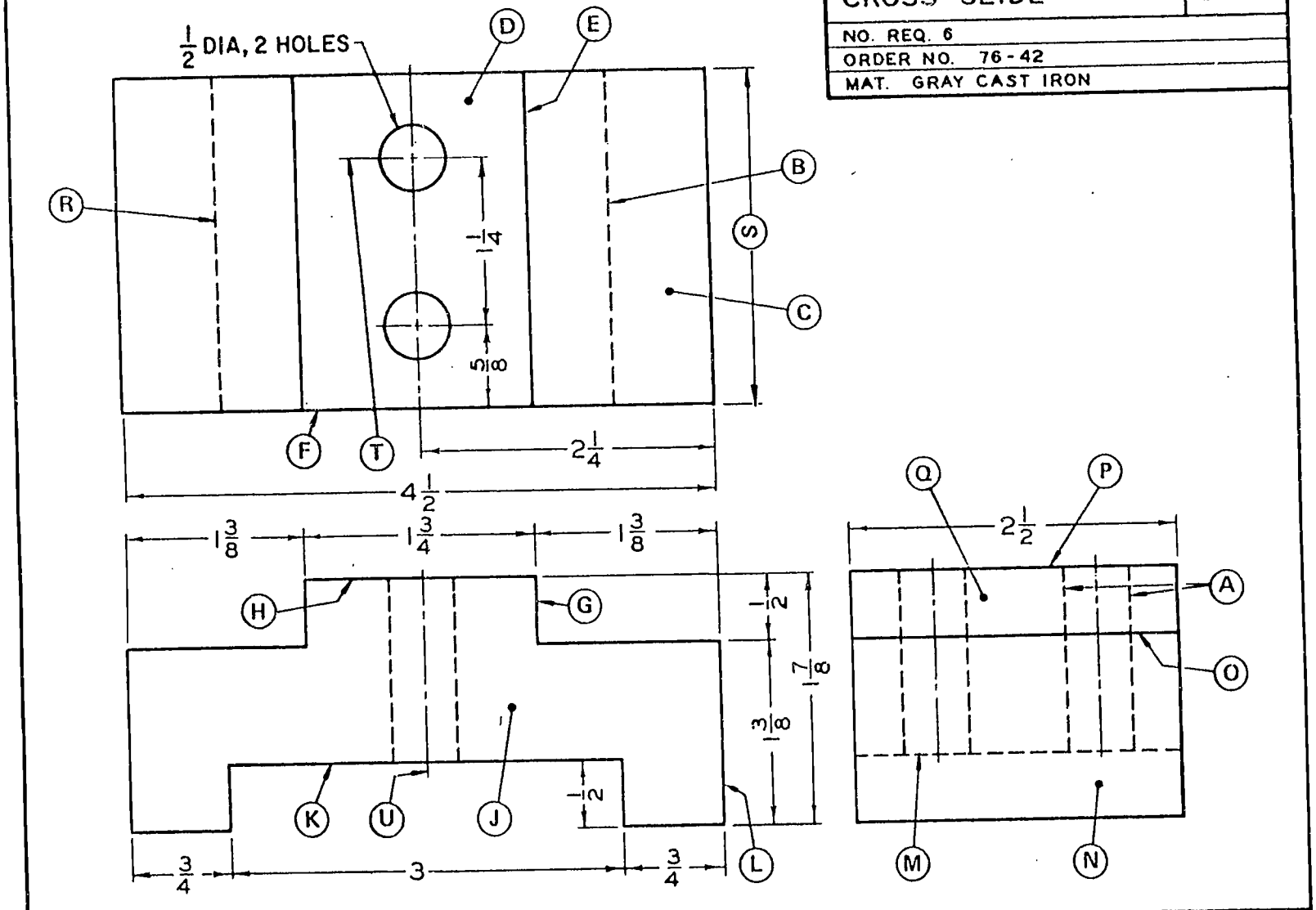
_____

21. LIST THE UPPER AND LOWER LIMITS IN THE FOLLOWING EXAMPLE:
11.75 $\pm$ .003 (Show your math)
-.001

_____upper _____lower

22. IN THE SPACE PROVIDED, SHOW THE SYSTEMATIC ARRANGEMENT OF THE FOLLOWING VIEWS: LEFT SIDE; FRONT; BOTTOM; TOP; RIGHT SIDE; AND REAR.

CROSS SLIDE	BP-6B
NO. REQ. 6	
ORDER NO. 76-42	
MAT. GRAY CAST IRON	



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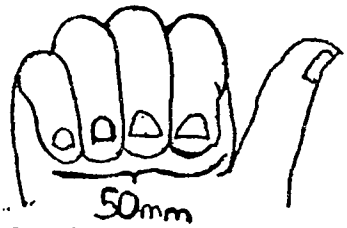
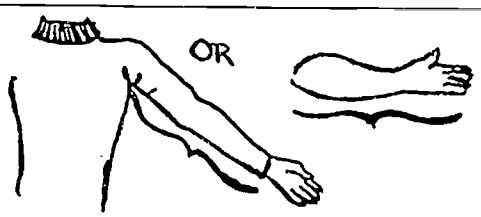
SMALL DISTANCES
BODY REFERENCES

OUR BODY GIVES US EASY REFERENCES FOR SMALL DISTANCES. ON THE AVERAGE, PRESSING YOUR FOUR FINGERS TOGETHER TO FORM A STRAIGHT EDGE, THE MEASURE WILL BE 50mm:



PRESS YOUR FINGERS TOGETHER LIKE THIS AND MEASURE THEM. IF YOUR FINGERS ARE LARGE, YOU MAY HAVE TO PRESS THEM CLOSER TOGETHER OR USE THREE FINGERS TO MEASURE 50 mm. IF THEY ARE SMALL, YOU MAY HAVE TO SPREAD THEM SLIGHTLY OR USE THE THUMB, TOO. ONCE YOU SEE HOW TO HOLD YOUR FINGERS TO MEASURE 50 mm, OR USE ANY OTHER BODY PART, YOU WILL HAVE A RULER THAT WILL ALWAYS BE WITH YOU.

THE CHART BELOW USES COMMON SIZES USING DIFFERENT BODY REFERENCES. MEASURE YOURSELF AND MAKE ADJUSTMENTS IN THE SIZES ON THE CHART. THEN MEMORIZE THE DIFFERENT LENGTHS.

SIZE		BODY REFERENCE
10mm		WIDTH OF THE TIP OF THE LITTLE FINGER OR THE WIDTH OF A FINGERNAIL
25mm		TIPS OF 2 FINGERS PRESSED TOGETHER
50mm		TIPS OF 4 FINGERS PRESSED TOGETHER
100mm		WIDTH OF HAND FROM THUMB KNUCKLE TO SIDE
200mm		LENGTH OF HAND
500mm		FROM ARMPIT TO WRIST OF HAND, OR FROM ELBOW TO FINGERTIPS

CONVERSIONS FROM CUSTOMARY UNITS TO METRIC UNITS
CONVERSIONS FROM METRIC UNITS TO CUSTOMARY UNITS

UNITS OF LENGTHS

1 m = 3.28 ft

1 cm= 0.39 in

1.61 km = 1 mi

.91 m = 1 yd

.305 m = 1 ft

2.54 cm = 1 in

1 m = 1.09 yd

"ACCURATE TO PARTS PER MILLION"

INCHES x 25.4	= MILLIMETERS	MILLIMETERS x .03970	= INCHES
FEET x .3048	= METERS	METERS x 3.28084	= FEET
YARDS x .9144	= METERS	METERS x1.09361	= YARDS
MILES x 1.60934	= KILOMETERS	KILOMETERS x.921371	= MILES

~ ~ ~

THE METRIC SYSTEM

THE BASIC UNIT OF LENGTH IN THE METRIC SYSTEM IS THE METER. ONE METER IS APPROXIMATELY THE LENGTH FROM A DOORKNOB TO THE FLOOR. ALL UNITS OF LENGTH IN THE METRIC SYSTEM ARE DERIVED FROM THE METER.

KILO- = 1000	**1 KILOMETER(km) = 1000 METERS(m)**
HECTO- = 100	**1 HECTOMETER(hm) = 100 METERS(m)**
DECA- = 10	**1 DECAMETER(dam) = 10 m**
DECI- = .1	**1 DECIMETER(dm) = .1 m**
CENTI- = .01	**1 CENTIMETER(cm) = .01 m**
MILLI- = .001	**1 MILLIMETER(mm) = .001 m**

****

* CONVERSIONS BETWEEN UNITS OF LENGTH IN THE METRIC SYSTEM *
* INVOLVES MOVING THE DECIMAL POINT TO THE RIGHT OR TO THE *
* LEFT. LISTING THE UNITS IN ORDER FROM LARGEST TO SMALLEST *
* WILL INDICATE HOW MANY PLACES TO MOVE THE DECIMAL POINT AND *
* IN WHICH DIRECTION. *
****

km	hm	dam	M	dm	cm	mm
.001	.01	.1	1	10	100	1000

EXAMPLES

1. ***CONVERTING "METERS" (M) TO MILLIMETERS (MM) REQUIRES MOVING 3 POSITIONS TO THE RIGHT.**
   MOVE THE DECIMAL POINT THE SAME NUMBER OF PLACES AND IN THE SAME DIRECTION. THEREFORE FROM THE CHART, WE CAN SEE THAT "1"M IS THE SAME AS "1000"MM.

2. **TO CONVERT 4200CM TO M REQUIRES MOVING 2 POSITIONS TO THE LEFT. MOVE THE DECIMAL PONT THE SAME NUMBER OF PLACES AND IN THE SAME DIRECTION.**
   THEREFORE, FROM THE CHART, WE CAN SEE THAT "4200" CM IS THE SAME AS "42"M.

ADDING FRACTIONS

BEFORE YOU CAN ADD FRACTIONS, THEY MUST HAVE LIKE DENOMINATORS. IN OTHER WORDS THE DENOMINATORS MUST BE THE SAME NUMBER. IN ORDER TO GET LIKE DENOMINATORS, YOU MAY HAVE TO MULTIPLY OR DIVIDE ONE OR ALL DENOMINATORS BY SOME NUMBER SO THAT THEY WILL BE THE SAME NUMBER. "BUT", IF YOU MULTIPLY OR DIVIDE THE DENOMINATOR BY SOME NUMBER YOU "HAVE**" TO MULTIPLY OR DIVIDE THE NUMERATOR BY THE SAME NUMBER. ONCE THE DENOMINATORS ARE THE SAME, THEN YOU ADD THE NUMERATORS AND KEEP THE LIKE DENOMINATOR. **FOR EXAMPLE:**

$$\begin{array}{rrrrrrrrl} & 1 & & 1 & \times & 2 & = & 2 & \text{IN THIS EXAMPLE YOU ONLY HAD TO} \\ & 2 & & 2 & \times & 2 & & 4 & \text{MULTIPLY ONE FRACTION BY "2" SO THAT} \\ + & 3 & + & 3 & & & + & 3 & \text{BOTH FRACTIONS WOULD HAVE THE SAME} \\ \hline & 4 & & 4 & & & & 4 & \text{DENOMINATOR.} \\ & & & & & & & 5 & \\ & & & & & & & 4 & \end{array}$$

AND

$$\begin{array}{rrrrrrrrl} & 3 & & 3 & \times & 3 & = & 9 & \text{IN THIS EXAMPLE, YOU HAD TO} \\ & 4 & & 4 & \times & 3 & = & 12 & \text{MULTIPLY THE FIRST FRACTION BY 3/3} \\ + & 1 & & 1 & \times & 2 & = & 2 & \text{AND THE SECOND BY 2/2 SO THAT BOTH} \\ \hline & 6 & + & 6 & \times & 2 & & 12 & \text{WOULD HAVE THE SAME DENOMINATOR} \\ & & & & & & = & 11 & \text{OF 12.} \\ & & & & & & & 12 & \end{array}$$

$$\begin{array}{rrl} & 2 & \text{IN THIS EXAMPLE, YOU DID NOT HAVE TO DO ANY CHANGING} \\ & 5 & \text{BECAUSE THE DENOMINATORS WERE ALIKE IN THE} \\ + & 1 & \text{BEGINNING. SO YOU ONLY HAD TO ADD THE NUMERATORS} \\ \hline & 5 & \text{AND KEEP THE LIKE DENOMINATORS.} \\ & 3 & \\ & 5 & \end{array}$$

SUBTRACTING FRACTIONS

**TO SUBTRACT FRACTIONS, YOU APPLY THE SAME RULES IN ADDING. BUT, IF THERE IS A MIXED FRACTION YOU MIGHT HAVE TO BORROW ONE FROM THE WHOLE NUMBER IN ORDER TO DO YOUR SUBTRACTION.

FOR EXAMPLE:

$$\begin{array}{rrrrrrrrrrrrr} & & & & & \text{B} & & & & & \text{C} & \\ & 4 & 1 & & 4 & 1 & \times 2 & = & 4 & 2 & 3 & 6 \\ & & 2 & & & 2 & \times 2 & & & 4& & 4 \\ - & 1 & 3 & - & 1 & 3 & & & -1 & 3 & -1 & 3 \\ \hline & & 4 & & & 4 & & & & 4 & & 4 \\ & & & & & & & & & & 2 & 3 \\ & & & & & & & & & & & 4 \end{array}$$

IN THE ABOVE EXAMPLE EVEN AFTER YOU HAD LIKE DENOMINATORS "4 2/4 AND "1 3/4", YOU COULD NOT TAKE "3" FROM "2" AS IN STEP B. THEREFORE IN STEP C YOU HAD TO BORROW 1 FROM THE FOUR. IN THIS CASE BORROW ONE MEANS TO BORROW IN THE FORM OF A FRACTION. SINCE OUR COMMON DENOMINATOR IS "4" WE NEED TO BORROW "4" "4s" OR 4/4. WHEN WE ADD 4/4 TO 2/4 THIS IS HOW WE CAME UP WITH OUR 6/4 IN STEP C. HERE WE WERE ABLE TO SUBTRACT 6 - 3 AND GET 3 AND

TOLERANCES

THE DIMENSIONS GIVEN ON A DRAWING ARE AN INDICATION OF WHAT THE LIMITS OF ACCURACY ARE. THESE LIMITS ARE CALLED TOLERANCES.
IN OTHER WORDS, A TOLERANCE IS THE AMOUNT OF ALLOWABLE DEVIATION OR CHANGE. IF A PART DOES NOT REQUIRE A HIGH DEGREE OF ACCURACY, THE DRAWING MAY SPECIFY THE TOLERANCES TO WHICH THE PART IS TO BE HELD IN TERMS OF FRACTIONAL DIMENSIONS. MORE PRECISELY MACHINED PARTS REQUIRE THAT THE ACCURACY BE GIVEN IN TERMS OF DECIMAL TOLERANCES.

SPECIFYING FRACTIONAL TOLERANCES:

"UNLESS OTHERWISE SPECIFIED: LIMITS ON FRACTIONAL DIMENSIONS ARE +/- 1/64"

THE ABOVE NOTE, WHEN INDICATED ON THE TITLE BLOCK OF BLUEPRINTS INDICATES THAT THE DIMENSION GIVEN IN FRACTIONS ON THE DRAWING MAY BE MACHINED ANY SIZE BETWEEN A 64th OF AN INCH LARGER TO A 64th OF AN INCH SMALLER THAN THE SPECIFIED SIZE.

THE LARGER SIZE IS CALLED THE "UPPER LIMIT" OR "THE HIGH SIDE OF THE TOLERANCE" AND THE SMALLER SIZE IS CALLED THE "LOWER LIMIT" OR "THE LOW SIDE OF THE TOLERANCE."

SPECIFYING ANGULAR DIMENSIONS

ANGLES ARE DIMENSIONED IN DEGREES OR PARTS OF A DEGREE

1. EACH DEGREE IS ONE THREE HUNDRED SIXTIETH OF A CIRCLE (1/360).
2. THE DEGREE MAY BE DIVIDED INTO SMALLER UNITS CALLED MINUTES. THERE ARE 60 MINUTES IN EACH DEGREE
3. EACH MINUTE MAY BE DIVIDED INTO SMALLER UNITS CALLED SECONDS. THERE ARE 60 SECONDS IN EACH MINUTE.

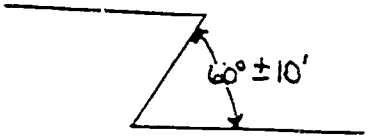
TO SIMPLIFY THE DIMENSIONING OF ANGLES, SYMBOLS ARE USED TO INDICATE DEGREES, MINUTES AND SECONDS. FOR EXAMPLE, TWELVE DEGREES, SIXTEEN MINUTES, FIVE SECONDS CAN ALSO BE WRITTEN 12 16'5".

	SYMBOL
DEGREES	°
MINUTES	'
SECONDS	"

THE TOLERANCE ON AN ANGULAR DIMENSION MAY BE GIVEN IN A NOTE SUCH AS:

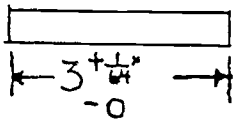
> UNLESS OTHERWISE SPECIFIED:
> LIMITS ON ANGULAR DIMENSIONS
> ARE +/- 1/2

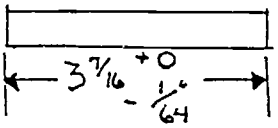
OR THE TOLERANCE MAY BE SPECIFIED ON ANGULAR DIMENSIONS

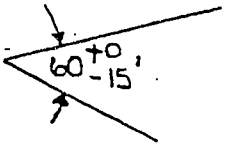


SPECIFYING DECIMAL TOLERANCES:

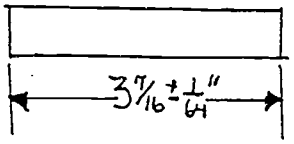
UNILATERAL TOLERANCES (SINGLE) INDICATES THAT THE TOTAL TOLERANCE ON A DIMENSION IS IN ONE DIRECTION ONLY, EITHER "+" OR "-".

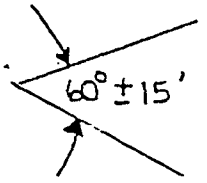






BILATERAL TOLERANCES APPLIED TO DIMENSIONS MEAN THAT THE DIMENSIONS MAY VARY FORM A LARGER SIZE (+) TO A SMALLER SIZE (-) THAN THE BASIC DIMENSION. IN OTHER WORDS, THE BASIC DIMENSION MAY VARY IN BOTH DIRECTIONS.

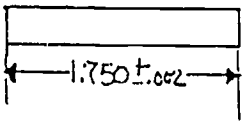




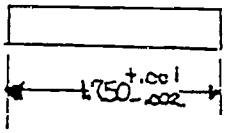
DECIMAL TOLERANCES CAN BE APPLIED IN BOTH THE ENGLISH AND THE METRIC SYSTEMS OF MEASUREMENT. TOLERANCES ON DECIMAL DIMENSIONS MAY BE GIVEN OF A DRAWING IN SEVERAL WAYS. ONE OF THE COMMON METHODS OF SPECIFYING TOLERANCES IS TO USE A NOTE:

> UNLESS OTHERWISE SPECIFIED:
> LIMITS ON DECIMAL
> DIMENSIONS ARE +/- .005"

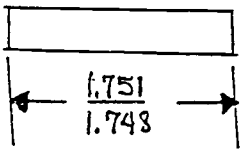
A TOLERANCE ON A DECIMAL DIMENSION MAY BE INCLUDED AS PART OF THE DIMENSION:



BILATERAL TOLERANCES ARE NOT ALWAYS EQUAL IN BOTH DIRECTIONS. IT IS COMMON FOR A DRAWING TO INCLUDE LITHER A (+) TOLERANCE OR A (-) TOLERANCE THAT IS GREATER THAT THE OTHER AND MAY BE SHOWN IN A DRAWING AS FOLLOWS:



THIS SAME VARIATION BETWEEN THE UPPER AND LOWER LIMIT CAN BE GIVEN AS BELOW. THE DIMENSION ABOVE THE LINE IS THE UPPER LIMIT THE DIMENSION BELOW THE LINE IS THE LOWER LIMIT.



NAME _____

DATE _____

TOLERANCING

GIVEN THE SPECIFICATIONS AND TOLERANCES, LIST THE LOWER AND UPPER LIMITS. "SHOW YOUR WORK!"

1. $5/16 \pm 1/64$

2. $3 \pm .015$

3. $7.375 \pm .007$

4. $4.125 \begin{matrix} +.003 \\ -.001 \end{matrix}$

5. $5.5 \begin{matrix} +.001 \\ -.002 \end{matrix}$

6. $12.9 \begin{matrix} +0 \\ -.11 \end{matrix}$

7. $\begin{matrix} 3.15 \\ 3.00 \end{matrix}$

8. $45^\circ \pm 10'$

9. $90^\circ \pm 1/2^\circ$

10. $60^\circ \begin{matrix} \pm 15' \\ -0' \end{matrix}$

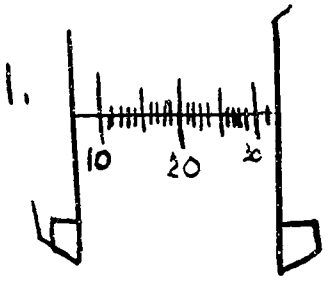
GIVEN THE SPECIFICATION AND TOLERANCES, TELL WHETHER THE ACTUAL READING IS WITHIN TOLERANCE.

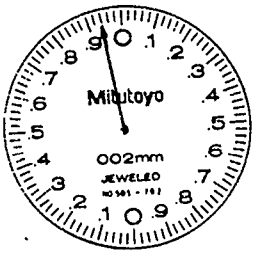
SPECIFICATION	ACTUAL READING
11. $11.625 \pm .009$	11.619 ____Y ____N
12. $90^\circ \pm 1/2^\circ$	89° _____ Y_____ N
13. $14.8 \begin{matrix} +0 \\ -.001 \end{matrix}$	14.76 _____Y ____N
14. $6.8 \begin{matrix} +.003 \\ -.001 \end{matrix}$	6.897_____ Y _____N
15. $1\ 3/8 \pm 1/64$	1.361 _____Y _____N

NAME _____ DATE _____

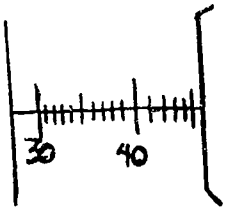
SCORE _____

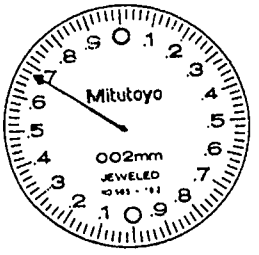
DIRECTIONS: LIST THE MEASUREMENTS FOUND ON THE CALIPERS BELOW.

1. 

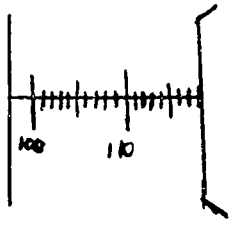


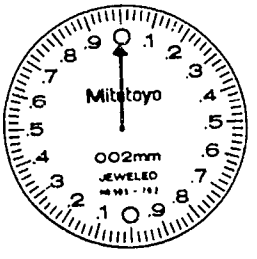
1. _____ mm

2. 



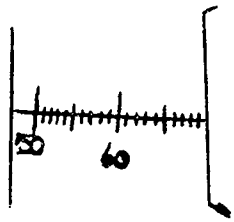
2. _____ mm

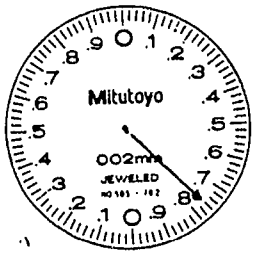
3. 



3. _____ mm

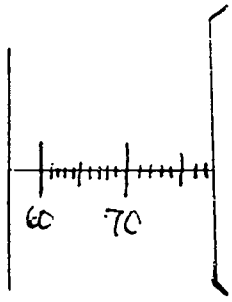
4.

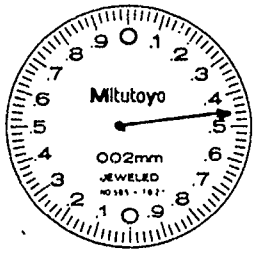




4 _____ mm

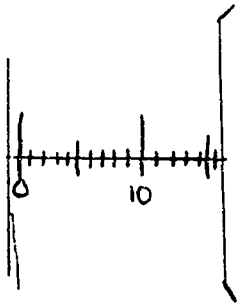
5.

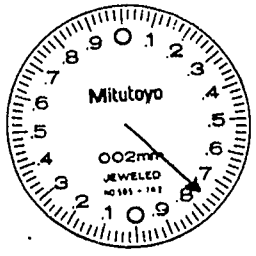




5. _____ mm

6.





6 _____ mm

INTRODUCTION

"BLUEPRINTS...THE LANGUAGE OF INDUSTRY"

What are BLUEPRINTS? A blueprint is a copy of a drawing which tells whoever is reading it - mechanic, technician, etc, - what the object or part will look like when its finished . In other words, it's a "roadmap" that aids the reader.

You've heard the saying "a picture is worth a thousand words. "This is certainly true when referring to blueprints in industry! These prints are universal, in other words, any competent reader will understand them. Each industry may have their individual relative information printed on their blueprint.

"Blueprint", "print", "plan", and "drawing" will be used throughout this course when referring to blueprints.

Blueprint reading is securing (getting) information from a plan. This involves two (2) major things:

1. VISUALIZATION *2. INTERPRETATION*

that work in conjunction with each other.

Visualization is the ability to "see" or visualize the size and shape of an object from the views on a plan.

Once you learn the different lines, symbols, dimensions, notes and other information on a print, this will become an important factor in helping you to interpret the drawing.

VIEWS

BLUEPRINTS SHOW THE SHAPE AND SIZE OF DRAWINGS BY MEANS OF A NUMBER OF VIEW OR PICTURES. THE VIEWS ARE ARRANGED SYSTEMATICALLY ON A DRAWING. EACH VIEW SHOWS HOW AN OBJECT APPEARS FROM A DIFFERENT LOCATION I.E. DEPENDING ON "**HOW YOU LOOK AT IT!**"

THESE VIEWS SHOULD BE CONNECTED BY THE READER TO FORM AN IMAGINARY PICTURE OF THE PART OR PRODUCT.

SINCE THE COMPLEXITY AND ARRANGEMENT OF VIEWS DEPENDS UPON THE COMPLEXITY OF THE PARTS, *VIEWS SHOULD NOT BE DRAWN UNLESS IT MAKES READING A DRAWING EASIER.*

"SEE ATTACHED PICTURE OF VIEWS"

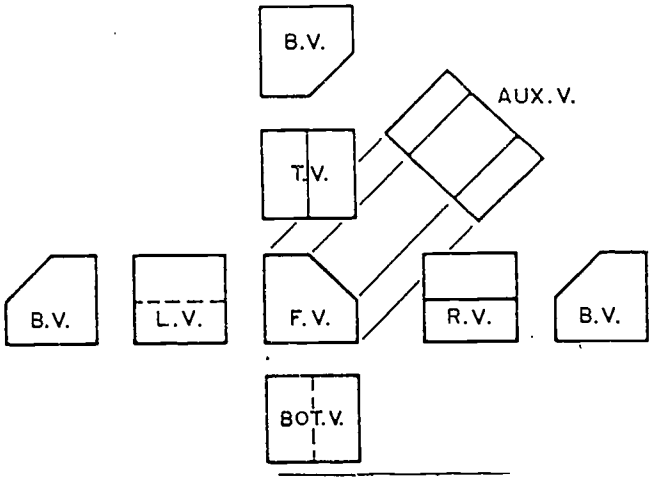
AUXILIARY VIEW

SOME OBJECTS HAVE 1 OR MORE SIDES WHICH SLANT AND ARE INCLINED AWAY FROM EITHER A VERTICAL OR HORIZONTAL PLANE. IN THIS CASE, REGULAR VIEWS WILL NOT SHOW THE TRUE SHAPE OF THE INCLINED SURFACE. IF THIS TRUE SHAPE IS TO BE SHOWN, THE DRAWING MUST INCLUDE AN AUXILIARY VIEW TO REPRESENT THE ANGULAR OR INCLINED SURFACE.

VIEWS

LISTED BELOW ARE THE TYPICAL VIEWS THAT ONE MIGHT FIND ON A BLUEPRINT. IT IS NOT ONLY IMPORTANT TO REMEMBER THE VIEWS BY NAME, BUT ALSO TO REMEMBER THEIR RESPECTIVE POSITIONS!

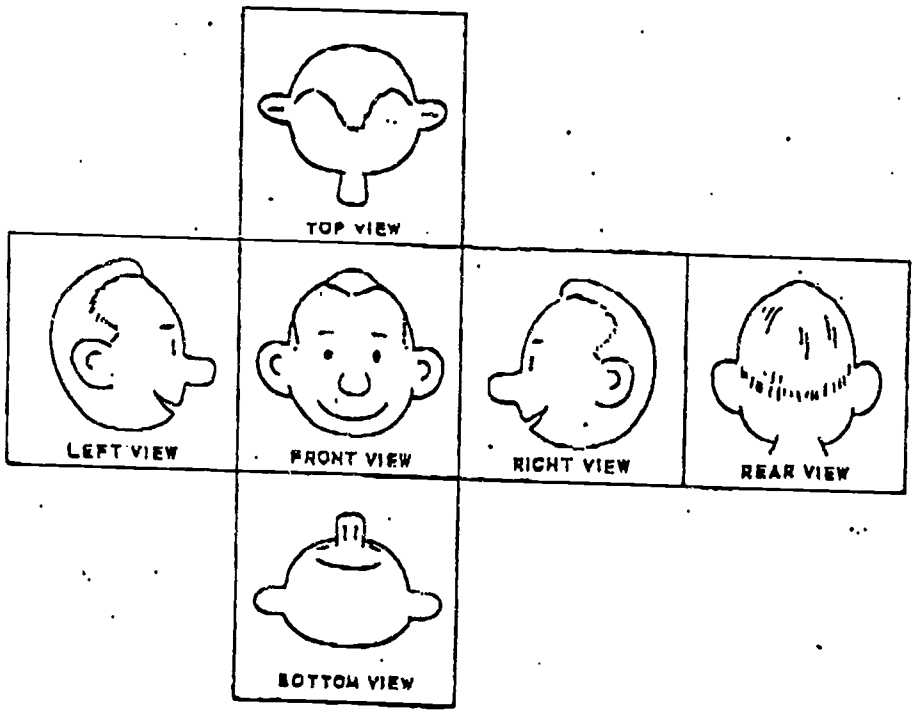
- Front view – F.V.
- Top view –T.V.
- Right-side view – R.V.
- Left-side view – L.V.
- Bottom view – Bot. V.
- Auxiliary view – Aux. V.
- Back or rear view – B.V.



VIEWS

ON A

BLUEPRINT



TO UNDERSTAND HOW PLAN VIEWS ARE OBTAINED, VISUALIZE A CLOWN'S HEAD TO BE ENCLOSED IN A GLASS BOX. YOU ARE ON THE OUTSIDE LOOKING IN AND YOU SHIFT YOUR POSITION AND LINE OF SIGHT AROUND THE BOX TO OBTAIN THE VARIOUS VIEWS. SINCE THE BOX HAS SIX SIDES, SIX VIEWS COULD BE OBTAINED AND USED IF REQUIRED TO PROVIDE COMPLETE DETAILS.

TYPES OF DRAWINGS

DETAIL DRAWINGS

A detail drawing is a drawing of a single part and provides all of the information necessary for the production to that part.

It will include:

1. **part name**

2. **shape and description of the part**

3. **dimensional size of the part and features**

4. **NOTES : detailing material, special machining/manufacturing information, finish, heat treatment, etc.**

** Usually 1 part is on a detail drawing but some industries may put several related parts on a single detail drawing.

ASSEMBLY DRAWING

Industrial drawings usually consist of more than one part which must be put together to form an assembly. To describe the relationship of these parts in the completed unit, an assembly drawing is provided. The assembly drawing:

*describes how the completed unit should look

*provides a bill of materials for manufactured or purchased parts

*identifies the details and quantities required for the assembly

WORKING DRAWING

To complete a drawing, dimensions and other information are added to the projected views. The drawing then becomes a working drawing. Such drawings furnish the information necessary from the construction of an object.

BLUEPRINT SYMBOLS AND ABBREVIATIONS

"R" stands for **radius** - a straight line expending from the center of a circle to the circumference or surface.

" O " stands for diameter - a straight line that passes through the center of a circle and divides it in half.

"Revision Letter" **Indicated by a triangle containing a letter:** letter reference in the revision block to indicate where changes have taken place on the blueprint.

"letters across top and bottom, and numbers along sides establish **zones** for reference in finding specific features.

"Datums" - Points, lines, surfaces or planes of a part that are assumed to be exact for purpose of reference and from which the location of other features are established. The datum plane is indicated by the assigned letter with dashes on either side, enclosed in a small rectangle or box.

BLUEPRINT TERMS - TITLE BLOCK

TITLE BLOCK - Usually located in the lower right-had corner of the blueprint, a box containing additional information on the part or assembly to be made, and information that will aid in the identification and filing of the print. The following lists and defines each piece of information contained within the title block:

1. **Drawing title** - refereed to on UTA drawings as "Part Name", a brief, clearly stated description identifying the part or assembly. The title starts with the name of the part or assembly, sometimes followed by descriptive modifiers.

2. **Drawing number** - referred to on UTA drawings as "Part No.", used to identify and control the blueprint, also used to designate the part or assembly shown on the blueprint. The number is usually coded to indicate department, model, group, serial number and dash numbers. On UTA blueprints, the part number is coded as follows: model year - part number - version (may indicate left or right, or color).

3. **Dash numbers** - (a number preceded by a dash after the drawing number) indicate right or left-hand parts as well as neutral parts and/or detail and assembly drawings. When coded, these are usually special to the particular industry, and are not universally applicable to all industries.

4. **Sheet** - sheet numbering is used on multisheet blueprints to indicate the consecutive order and the total number of prints. On UTA blueprints, sheet numbers will appear under the part name or part number, but only if there is more than one sheet.

5. **First Used** - on UTA Drawings, represents a sub-assembly number, referring to a bill of materials. The number given is the number of the finished part, of which the individual part drawn is a component.

6. **Status - M** (Manufactured) or **P** (Purchased) used to indicate the source of the part produced.

7. **Scale** - The drawing scale indicates the comparative size between the part as drawn and the actual part. Typical scale notations appear as 4X and 2X for parts used at UT. These indicate that the drawings have been enlarged from the actual size 4 times, and 2 times, respectively.

8. **Tolerances** - Indicates the general tolerance limits for one, two and three place decimal and angular dimensions. These limits are applicable unless the tolerance is given along with the dimension callout. On UTA blueprints, tolerances for linear dimensions (lines) are given by each callout. Standard angular tolerances age given in the title block.

ALPHABET OF LINES

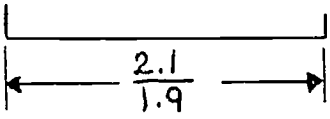
1. **OBJECT LINE** - CLEARLY EMPHASIZES THE OUTLINE OR SHAPE OF AN OBJECT ON A PLAN. USUALLY DRAWN HEAVY AND SOLID.

2. **HIDDEN LINES** - REPRESENTS ALL THE EDGES AND INTER-SURFACES OF THE OBJECT. MANY OF THESE LINES ARE INVISIBLE TO THE READER BECAUSE THEY ARE COVERED BY OTHER PORTIONS OF THE OBJECT. USUALLY DRAWN BY USING A SERIES OF SHORT DASHES.

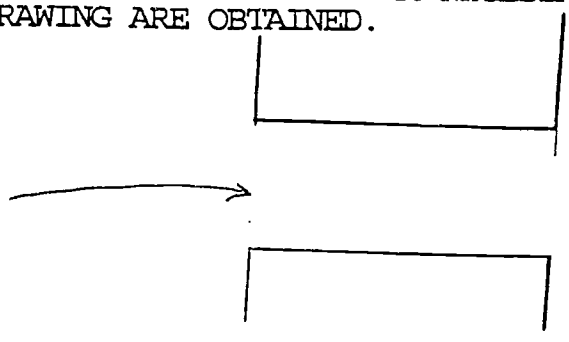
3. **CENTER LINES** - DRAWN AS A LIGHT BROKEN LINE OF LONG AND SHORT DASHES, SPACED ALTERNATELY. CENTER LINES ARE USED TO INDICATE THE CENTER OF A WHOLE CIRCLE OR PART OF A CIRCLE AND TO SHOW THE OBJECT IS SYMMETRICAL ABOUT A CIRCLE.

4. **EXTENSION LINES** - USED IN DIMENSIONING TO SHOW SIZE OF AN OBJECT. THEY ARE LIGHT, SOLID LINES WHICH EXTEND FROM AN OBJECT IN THE EXACT PLACES BETWEEN WHICH DIMENSIONS ARE TO BE PLACED.

5. **DIMENSION LINES** - ARE LIGHT, SOLID LINES (EXCEPT AT DIMENSIONS) WITH ARROWHEADS AT EACH END. THE TIPS OR POINTS OF THE ARROWHEADS INDICATE THE EXACT DISTANCE REFERRED TO BY A DIMENSION.



6. **PROJECTION LINES** - ARE USED BY DESIGNERS TO ESTABLISH THE RELATIONSHIP OF LINES AND SURFACES IN ONE VIEW WITH CORRESPONDING POINTS IN ANOTHER VIEW. THEY ARE FINE, UNBROKEN LINES. PROJECTED LINES DO NOT APPEAR ON FINISHED DRAWINGS UNLESS THE PART IS COMPLICATED AND IT BECOMES NECESSARY TO SHOW HOW CERTAIN DETAILS ON A DRAWING ARE OBTAINED.

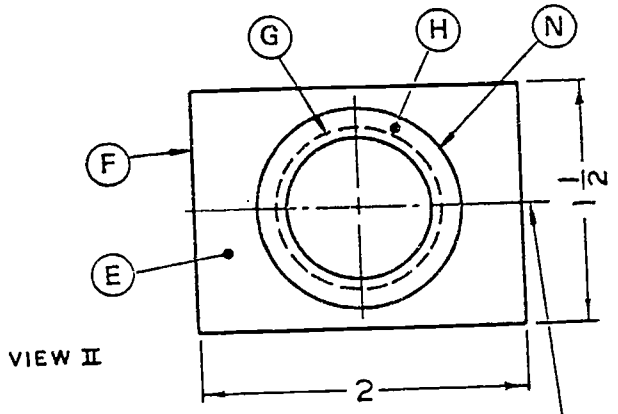


NAME _____ DATE _____

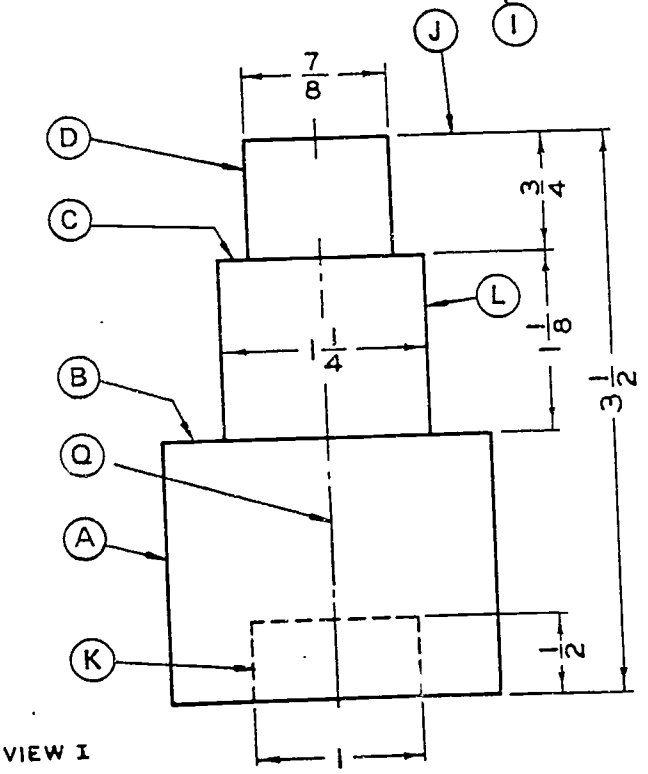
SCORE _____

DIRECTIONS: USING THE ATTACHED BLUEPRINT, ANSWER THE FOLLOWING QUESTIONS. ALL DIMENSIONS ARE IN INCHES.

1. NAME THE TWO VIEWS SHOWN. _____ _____
2. WHAT LINE IN VIEW II REPRESENTS SURFACE **A**? _____
3. WHAT LETTERED SURFACE IN VIEW II REPRESENTS SURFACE **B**? _____
4. WHAT CIRCLE IN VIEW II REPRESENTS THE 1" HOLE? _____
5. WHAT LINE IN VIEW I REPRESENTS SURFACE **H**? _____
6. WHAT KIND OF LINE IS **H**? _____
7. WHAT KIND OF LINE IS **D**? _____
8. WHAT KIND OF LINE IS **J**? _____
9. WHAT KIND OF LINE IS **K**? _____
10. WHAT CIRCLE IN THE TOP VIEW REPRESENTS DIAMETER **L**? _____
11. WHAT LETTERS IN VIEW 1 REPRESENT OBJECT LINES? _____
12. WHAT LETTERS IN VIEWS 1 AND 2 REPRESENT CENTER LINES? _____
13. GIVE THE DIAMETER OF **L**. _____
14. WHAT IS THE SMALLEST DIAMTER OF THE SHAFT? _____
15. DETERMINE THE LENGTH OF THE 1 1/4" DIAMETER PORTION? _____
16. WHAT IS THE LENGTH OF THE RECTANGULAR PART OF THE SHAFT? _____
17. GIVE THE OVERALL LENGTH OF THE SHAFT? _____



VIEW II



VIEW I

NO. REQ. 32	
ORDER NO. 76 - 32 - 05	
MATERIAL COLD DRAWN STEEL (C.D.S.)	
END SHAFT	BP-8A

ENT LOCATION
- NEW PART
- CERTIFIED
- PURCHASED
- MANUFACTURED
- DRAWING

ST. MATTHEWS #64

UNITED TECHNOLOGIES AUTOMOTIVE
INPUT CONTROLS & ELECTRONICS
BILL OF MATERIAL

PART NO. 92-7315-1 DR. SIZE R
CUST. NO. FOVB-14A626-AG

NAME KEYLESS ENTRY SWITCH (TOWN CAR- SERVICE)

	PART NO.	STATUS	DR. SIZE	DESCRIPTION	NO. REQ'D
B	*92-7301-1	P	E	HOUSING	1
B	*92-7311-1	P	D	BOOT	1
	*92-7313-1	M	D	CROSSMEMBER, SP BLOCK, PC BD, WIRE ASSY	1
B	*92-7314-1	P	D	CROSSMEMBER	1
B	*92-7317-1	P	D	SPACER BLOCK	1
	*92-7318-1	M	C	PC BOARD ASSY	1
B	*92-7319-1	P	D	PC BOARD	1
	*92-7321-1	P	C	TACT SWITCH	5
	12-72	P	#	SOLDER	0.6g
	*92-7322-1	P	B	EYELET-STIMPSON A-2059	2
	*499-56	P	C	LAMP - ELECTRO-LUMINESCENT	1
	*92-0001-32	M	D	WIRE ASSY	1
				WIRE - SW. 1/2 CIR. #76	480mm
				WIRE - SW. 3/4 CIR. #79	450mm
				WIRE - SW. 5/6 CIR. #121	435mm
				WIRE - SW. 7/8 CIR. #122	435mm
				WIRE - SW. 9/0 CIR. #123	450mm
				WIRE - COMMON (INPUT) CIR. #124	480mm
		P	#	TERMINAL (FORD NO. E8EB-14488-AJA)	6
	*92-7327-1	P	C	INVERTER ASSY	1
		P	#	INVERTER	1
	*92-0001-33	P	B	WIRE ASSY	1
		P	#	WIRE (LT BLUE)	275mm
		P	#	TERMINAL (FORD NO. E8EB-14488-AJA)	1
	*92-0001-34	P	B	WIRE ASSY	1
		P	#	WIRE (BLACK)	275mm
		P	#	TERMINAL (FORD NO. E8EB-14488-AJA)	1
		P	B	WIRE (LT BLUE)	155mm
		P	B	WIRE (BLACK)	155mm
		P	#	CONNECTOR (FORD D2SB-14489-KA)	1
		P	#	WEDGE (FORD D1AB-14A468-BA)	1
		P	#	CAPILLARY TUBE (FORD ESB-M4D317-A)	1
		P	#	RETAINER (FORD E3DB-13A506-AA)	1
		P	#	LOOM- .375 ID 50MM FORD ESB-M3L38-A	2
	25-0106-B	P	#	TAPE (WRAP) (FORD ESB-M3G40-A) (80")	1000mm
B	26-0806-C	P	#	TAPE (END TIE) (FORD ESB-M3G71-A) (16")	500mm
		P	#	IDENT. TAPE-YELLOW (I.T.T. 0906-0750-1444)	1
B	*92-7328-1	P	B	ROLLED FLANGE EYELET	1
	20-252	P	A	CONFORMAL COATING	0.1g
B	*92-7331-2	P	B	COILED PIN	3
	11-25	P	#	RTV - ADHESIVE SEALANT	7g
B	*92-7329-2		C	GASKET	1
	*20-258	P	#	LOCTITE 411-61	
	*20-259	P	#	XMS CLEANING SOLVENT	
				X NUMBER: 32X7315AA	

DISTRIBUTION

1 2 3 4 5 6
7 8 9 10 11 12
13 14 15 16 17 18
19 20 21 22 23 24
25 26 27 28 29 30

LET.	E.C.N. #	DATE	LET.	E.C.N. #	DATE
A	ISSUED	07-17-92			
B	REVISED/22920	09-30-92			

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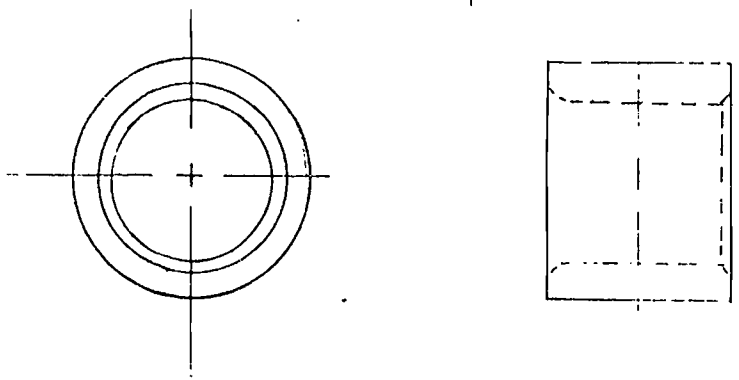
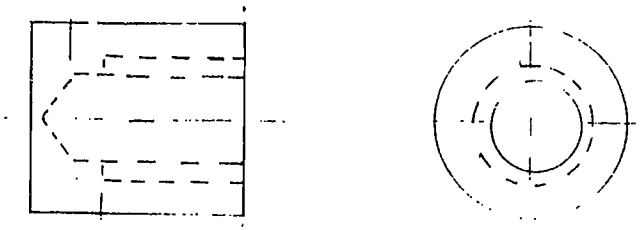
ERIC

DIRECTIONS: THERE ARE FOUR PIECES ON THE TABLE. IDENTIFY THE TWO PIECES BELOW FROM THOSE FOUR PIECES.



PART NAME _____

40



PART NAME _____

UNITED TECHNOLOGIES

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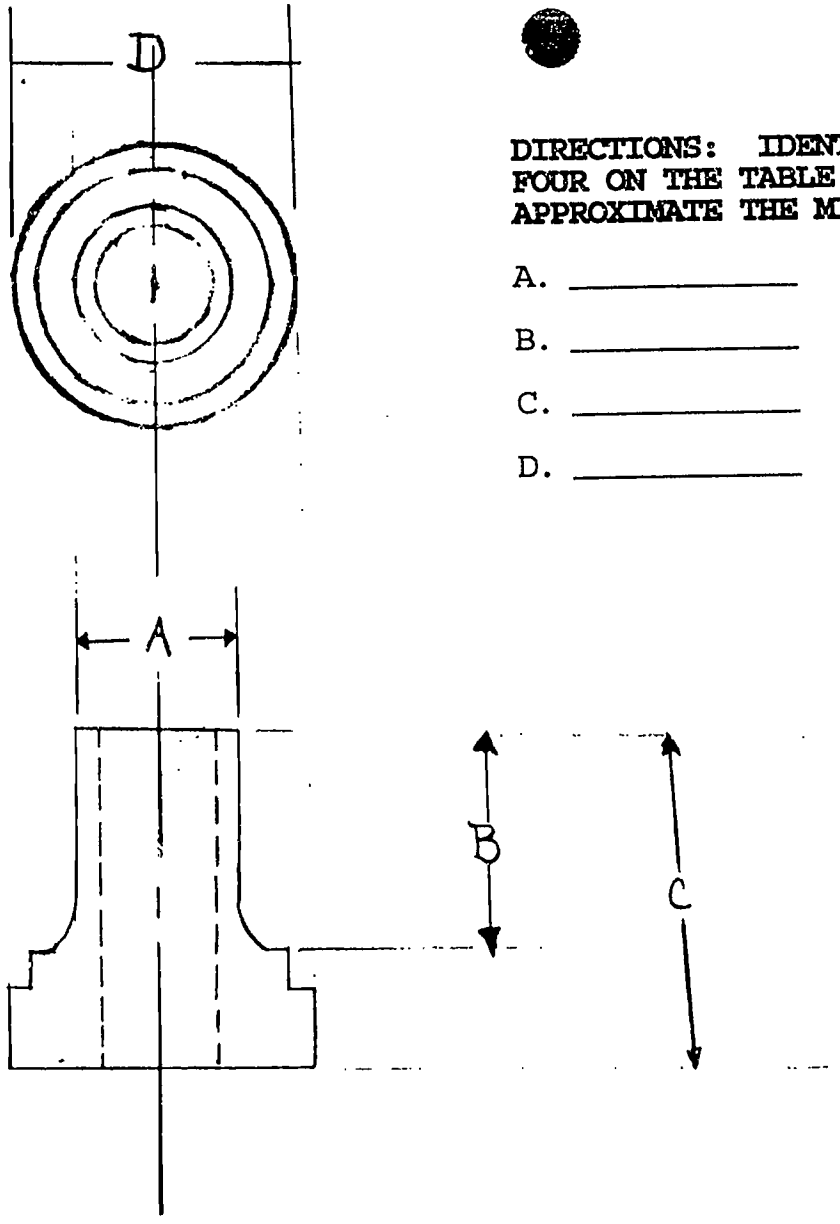
NOT TO SCALE

6 - 8 - 94



DIRECTIONS: IDENTIFY THE FOLLOWING PART FROM THE FOUR ON THE TABLE. USING YOUR BODY PARTS, APPROXIMATE THE MISSING DIMENSIONS.

A. _____

B. _____

C. _____

D. _____

PART NAME _____

DIRECTIONS: YOU HAVE BEEN GIVEN FOUR (4) DIFFERENT VIEWS OF A HOUSING - REAR VIEW AND THREE SECTIONAL VIEWS. CERTAIN DIMENSIONS ARE HIGHLIGHTED ON EACH VIEW. YOUR ARE TO:

1. USE YOUR CALIPERS AND MEASURE THE HIGHLIGHTED DIMENSIONS.

2. LIST THE DIMENSION NUMBER AND BESIDE IT WRITE THE DIMENSION YOU GOT IN #1 ABOVE.

3. TELL IF THE DIMENSION IS IN TOLERANCE ACCORDING TO THE PRINT BY WRITING YES OR NO.

4. EACH HOUSING HAS SOME IDENTIFYING NUMBERS/LETTERS. WHENEVER YOU MEASURE A DIMENSION, IF IT IS NECESSARY IDENTIFY WHICH NUMBER/LETTER YOU TOOK YOUR READING FROM.

5. WHEN MATH IS NEEDED TO DETERMINE A DIMENSION, SHOW ALL OR YOUR MATH WORK.

6. ALL OF YOUR WORK IS TO BE DONE ALONG WITH YOUR PARTNER. I SUGGEST THAT EACH OF YOU TAKE A READING FOR THE DIMENSION AND THEN COLLABORATE AS TO WHICH DIMENSION YOU WILL WRITE DOWN FOR ME.

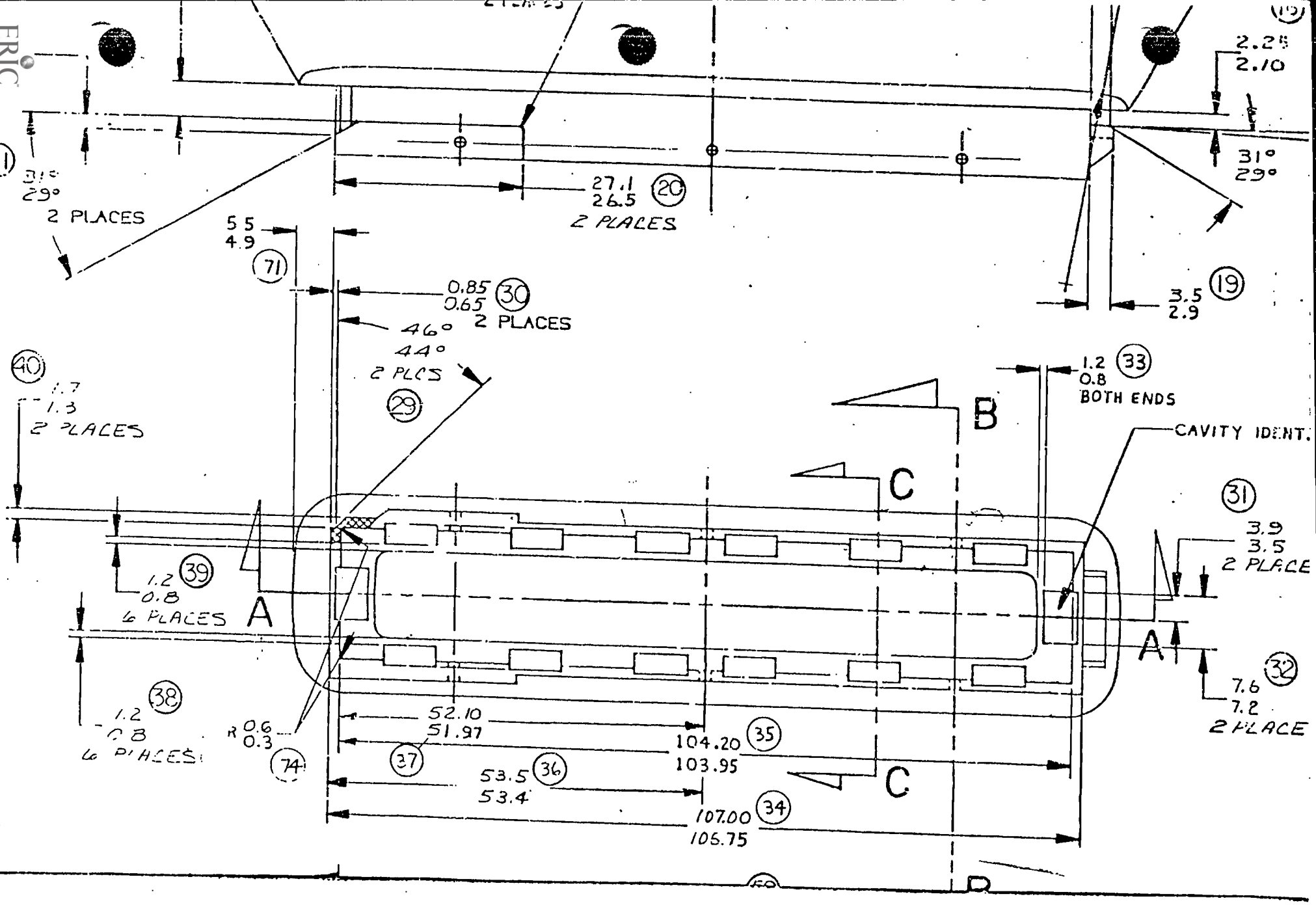
7. FOR EXAMPLE YOUR PAPER THAT YOU TURN INTO ME SHOULD LOOK SOMETHING LIKE THIS:

NAMES(S) _____ DATE _____

_____ SCORE _____

PART NO. _____ CALIPER NO. _____

DIM. NO.	MY READING	Y/N TOLERANCE	"X" OR "Y" SIDE	IDENTIFYING LETTER/NO.



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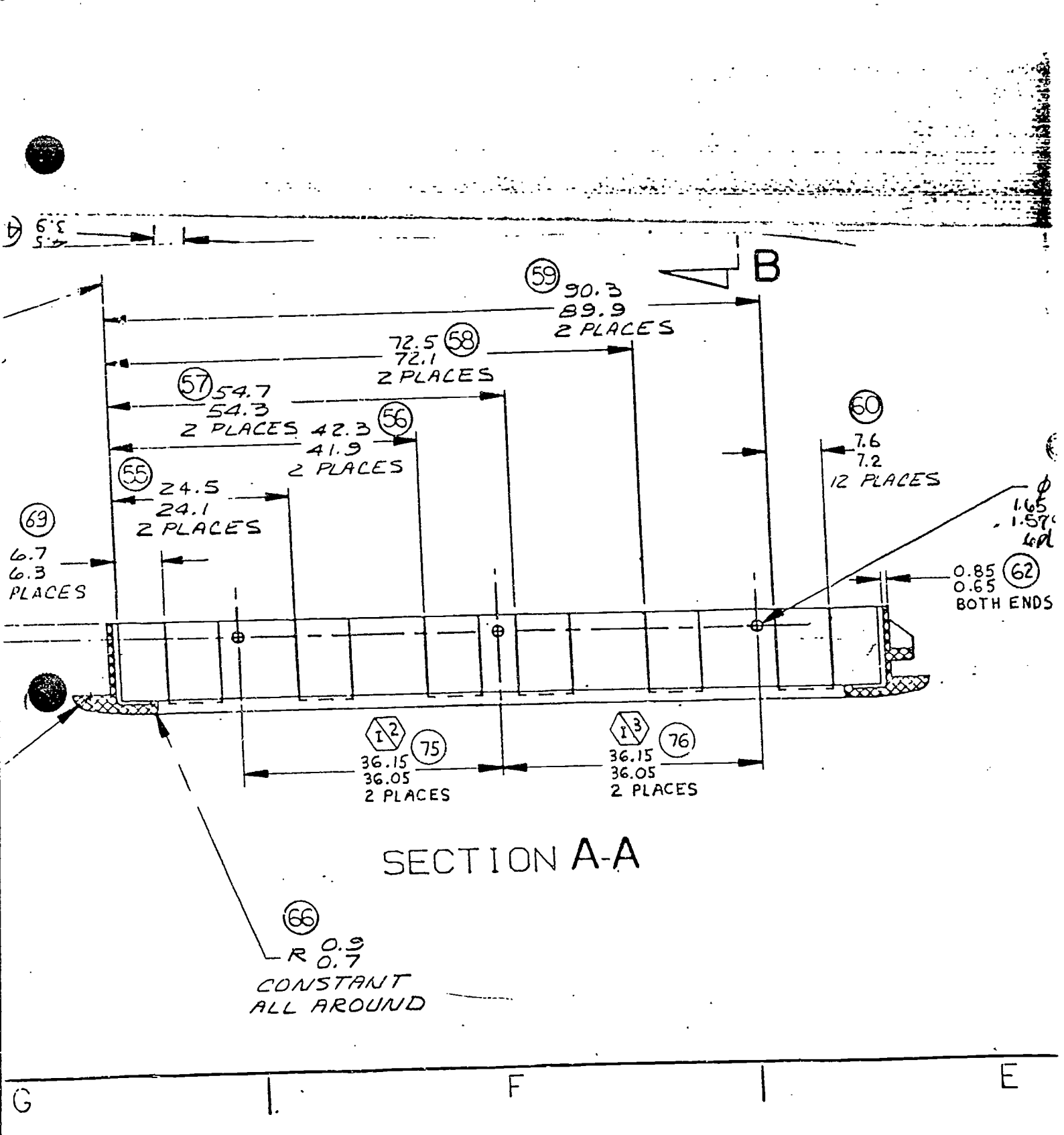

SECTION A-A

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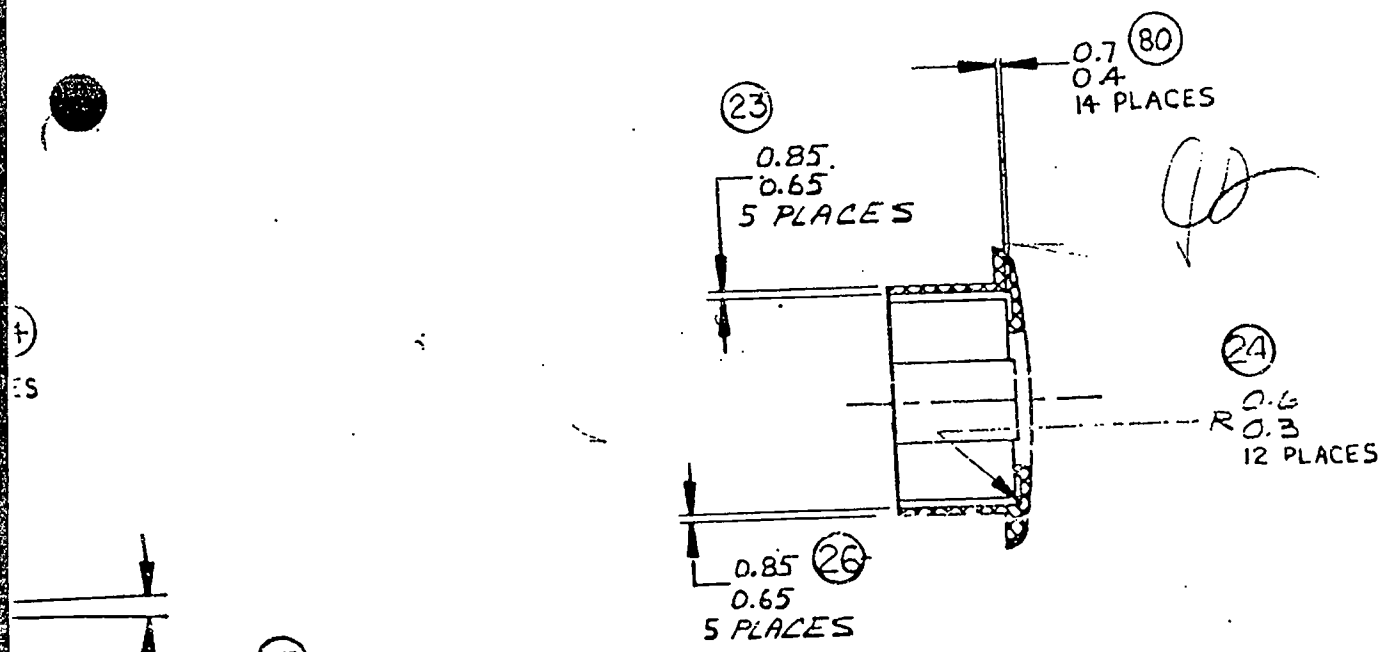
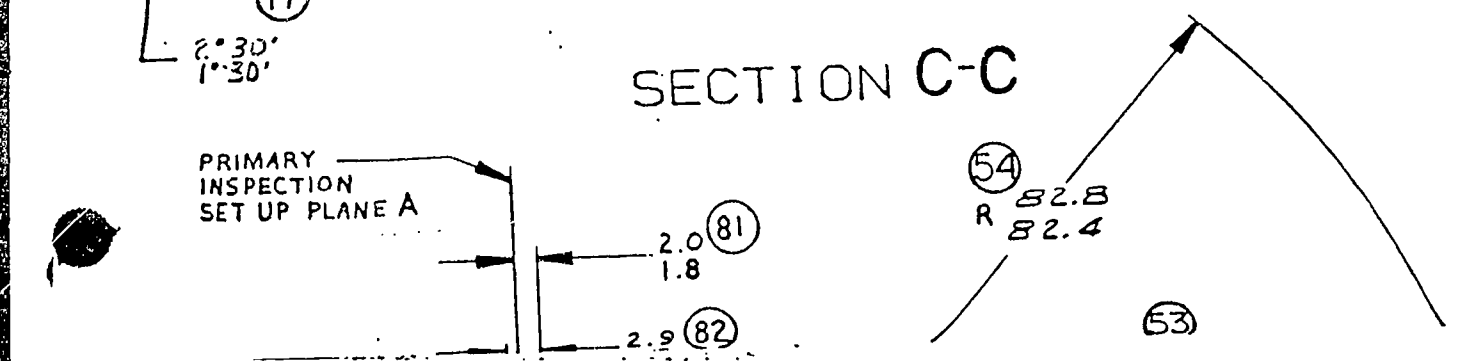


SECTION C-C



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